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THE CONTROL OF THE BOLL WEEVIL.

BY

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., April 4, 1912.

SIR: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin a manuscript prepared by Mr. W. D. Hunter, of this bureau, entitled "The Control of the Boll Weevil."

The matter contained in this manuscript is extracted largely from Bulletin 114, of this bureau. That publication is a comprehensive treatment of all phases of the boll-weevil problem. The object in reprinting a portion of it is to place the matter relating to practical control in form for more economical distribution among the planters.

Respectfully,

L. O. HOWARD,
Entomologist and Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE CONTROL OF THE BOLL WEEVIL.

INTRODUCTION.

The matter contained in this bulletin is extracted largely from Bulletin No. 114 of this bureau.[1] That publication contains a rather exhaustive account of the history of the boll weevil in the United States and in other countries, its life history and habits, and numerous methods of control that have been suggested from time to time. The reader is referred to the larger publication for much fuller information regarding many of the points discussed in this circular.

The work on the boll weevil is being continued, and there are definite indications of a successful outcome from experiments in control that will add still further to the planters' ability to combat the pest. This bulletin, however, contains a brief outline of the methods which have been tested under various conditions and sums up the present available knowledge concerning the subject of control.

The difficulties in the way of controlling the boll weevil lie both in its habits and manner of work and in the peculiar industrial conditions involved in the production of the staple, cotton, in the Southern States. In all stages except the imago the weevil lives within the fruit of the plant, well protected from any poisons that might be applied. The adult takes food normally only by inserting its snout within the substance of the plant. It frequently requires but 12 days for development from egg to adult. The progeny of a single pair in a season may exceed 12,000,000 individuals. It adapts itself to climatic conditions to the extent that the egg stage alone in November may occupy as much time as all the immature stages together in July or August. All of these factors combine to make it one of the most difficult insects to control.

BASIS FOR MEANS OF REPRESSION.

In spite of the many difficulties involved in the control of the boll weevil certain generally satisfactory means of repression are at hand, and others may be found as the result of future work. They consist of both direct and indirect means. Those of an indirect nature are designed to increase the advantage gained by the direct

[1] Bul. 114, Bureau of Entomology, U. S. Dept. Agriculture, "The Mexican Cotton Boll Weevil," by W. D. Hunter and W. D. Pierce. Also issued as Senate Doc. No. 305, 62d Cong., 2d sess.

measures and to increase the effectiveness of the several natural factors which serve to reduce the number of weevils. Thus the control measures constitute a combination of expedients, the parts of which interact in many ways. Naturally, the best results are obtained when the planter can put into practice all of the essential parts of the combination.

It is obvious that any method of controlling the boll weevil must depend upon full knowledge regarding its life history and the natural forces which tend to prevent its multiplication. Certain practices which upon superficial observation might be considered important in the control of the insect, upon investigation may be found to be of no avail whatever. In fact, in some cases what appear to be feasible means of control are worse than useless, because they tend to nullify the effects of natural forces which act against the weevil. This is notably the case with the practice of attaching a bar to a cultivator to jar the infested squares from the plants. As will be explained later, this practice is of advantage under only very restricted conditions. Throughout the greater part of the infested territory it is an assistance rather than a hindrance to the boll weevil.

There are seven features of the life history of the weevil that are of cardinal importance in control. These are indicated below.

(1) The weevil has no food plant but cotton.

(2) The mortality of the weevil during the winter is very high.

(3) The emergence from hibernating quarters during the spring is slow and prolonged until well into the summer.

(4) Early in the season, on account of comparatively low temperatures, the development of the weevil is much slower than during the summer months.

(5) The drying of the infested squares soon destroys the immature stages of the weevil contained therein.

(6) The weevil is attacked by many different species of insect enemies, the effectiveness of which is increased by certain practices.

(7) The weevil has but little ability to emerge when buried under wet soil.

Exactly how each of these features of the life history of the weevil affects plans for practical control will be explained in the following paragraphs:

In the case of many of the important injurious insects the problem of control is greatly complicated by the fact that the pests can subsist upon more than one food plant. In some cases a single species attacks several cultivated crops. In other cases the pests can subsist upon native plants practically as well as upon the cultivated species. All these difficulties are absent in the case of the boll-weevil problem. The insect is absolutely restricted to the cotton plant for food and for opportunities for breeding. The problem, therefore, is much more simple than it would be if the weevil could subsist upon any other plant in the absence of cotton. This peculiarity of the weevil (i. e.,

no food plant but cotton) was the basis of the recommendation made in 1894 that the pest be exterminated absolutely in the United States by the abandonment of cotton culture in a very restricted region. At that time only a few counties in Texas were affected. The procedure would have involved but small expense. Even now the weevil could be exterminated in a single season by preventing both the planting of cotton and the growth of volunteer plants throughout the infested territory. This proposal has been made at various times, notably at the National Boll-Weevil Convention held in Shreveport, La., in 1906. Various difficulties, however, appear to render the plan entirely impracticable. In the first place, there would be strong opposition in large regions in Texas where the planters have learned to combat the weevil successfully. Moreover, the expense would be enormous. A large army of inspectors would be required. The work would not end with the prevention of the planting of cotton, but would necessarily extend to the destruction of volunteer plants which would be found along roads and railroads, about gins and oil mills, and on plantations throughout the infested region. The loss to mills, railroads, merchants, banks, and others dependent upon the cotton trade would complicate matters further. Unless a plan of reimbursement were followed, there would be strenuous opposition from these quarters, and any scheme of payment for damages would add very materially to the cost. From a theoretical standpoint, all the expenses involved would be justified. The saving in a few years would more than offset the cost. Nevertheless, the practical difficulties undoubtedly will always prevent the execution of the plan. All interests now favor the necessary adjustment of conditions to the boll weevil and the practice of the known measures of control rather than total eradication, which was once practicable, but now little more than visionary.

In Bulletin No. 114 it was shown that during the several years in which careful experiments have been performed the average rate of winter survival was 7.6 per cent. It is noteworthy that frequently the survival is much smaller. In the experiments to which reference has been made it ranged from 0.5 per cent to 20 per cent. The most important means of controlling the boll weevil that are available are designed to increase this tremendous mortality caused by natural conditions during the winter. The destruction of any certain number of weevils during the winter is much more important than the destruction of much larger numbers at any other season. The best means at the command of the farmer for increasing the winter mortality is through the uprooting and burning or burial of the stalks at an early date in the fall. Numerous experiments have shown the increased mortality due to depriving the

weevils of their food at early dates in the autumn. In fact, the experiments showed a practically uniform increase in the number of weevils surviving as the dates of the destruction of the plants became later. For instance, in all of the experiments performed in Texas it was found that September destruction resulted in a survival of only 0.2 per cent; destruction two weeks later showed a survival of 2.3 per cent; destruction during the last half of October, 5.6 per cent; and during the first half of November, 15.4 per cent. The results of the Louisiana experiments were similar. Destruction in September showed a survival of 0.3 per cent; destruction in the first half of October, 2 per cent; in the last half of October, 8 per cent.

In addition to the experiments in which the weevils have been placed in cages at different times in the fall the Bureau of Entomology has conducted considerable field work to show the benefits of fall destruction. The most striking experiment was performed in Calhoun County, Tex., in 1906. In this experiment an isolated area of over 400 acres of cotton was utilized. There was no other cotton within a distance of 15 miles. By contracts entered into by the department, the farmers uprooted and burned all of the stalks during the first 10 days in October, 1906, and provision was made to prevent the growing of sprout cotton. As a check against this area, cotton lands about 30 miles away were used. Here the stalks were not destroyed in the fall, and the interpretation of the results of the experiment was based upon a comparison of the number of weevils present during the following season in the two localities. In May, 1907, following the destruction of the plants, careful search revealed only one weevil in the experimental area. In the check, however, the weevils were so numerous at this time that practically all of the squares had been destroyed. Examinations made later showed similar advantage in regard to freedom from the boll weevil of the area where the stalks had been destroyed the preceding October. The last examination was made on August 20, 1907. At this time there were 10 sound bolls per plant on the experimental area and only 3 per plant in the check area. The difference in yield between the two areas was about 600 pounds of seed cotton per acre. The work, therefore, resulted in an advantage amounting to about $18 per acre.

Newell and Dougherty [1] have described a very satisfactory device for cutting the cotton stalks in the fall. It consists of a triangular, V-shaped, wooden framework designed to pass between the rows and cut two at the same time. In the process of cutting the machine windrows the stalks from two rows in the middle near where

[1] Circular 30, Louisiana Crop Pest Commission.

they were standing. The runners are provided with knives made of sharpened metal. Old saws have been found well adapted to the purpose. It is important to provide a metal runner at the rear end of the machine to prevent sliding. This runner is designed to run an inch or more beneath the surface of the ground. The device can be made by any blacksmith at a cost of about $4. It will cut and windrow from 10 to 15 acres of stalks in a day.

There is a disadvantage in cutting the stalks at or near the surface of the ground; this is that if warm weather follows, many of the roots give rise to sprouts that will furnish food for the weevils. On this account the process is less effective than uprooting the plants. Wherever the stalk cutter is used it should be followed by plows to remove the roots from the ground.

There is another important means by which the winter mortality of the weevil may be increased. This is by removing the hibernating quarters or destroying them after the weevil has gone into hibernation. Many of the insects are to be found in the winter in trash and débris in and about cotton fields. The more shelter provided in the form of weeds growing about the fields, the more favorable the conditions will be for the insect. By the burning of such hibernating shelter as is found in the cotton fields and in their immediate vicinity a farmer can cut off a very large proportion of the weevils that would otherwise emerge to damage the crop.

The prolonged period of emergence from hibernation gives the planter another important advantage over the weevil. The period of emergence from hibernation extends, in normal seasons, to practically the 1st of July. In fact, except in one of the experiments performed, the last weevils did not appear until after the 20th of June. In Texas it was found that 75 per cent of the emerging weevils appeared after April 8, and in Louisiana 64 per cent. In Texas, after May 1, in all the experiments, from 4 to 18 per cent of the surviving weevils appeared. In Louisiana, after May 1 from 30 to 40 per cent emerged.

It is obvious that the fact that many weevils do not appear until long after cotton can be planted and brought to a fruiting stage is a very great advantage to the planter. A portion of a crop, at least, can be set before the weevils have become active. Usually it is possible to plant a crop sufficiently early to have it set some fruit before much more than 50 per cent of the surviving weevils have emerged.

Attention was directed to the fact that the development of the weevil is much slower in the early portion of the season than later. For instance, at Vicksburg, Miss., the average period of development in April is 30 days, and in May 19 days. In June the period is shortened to 15 days. Consequently, the planter has an opportunity

to force the development of fruit on the plants when the weevils are being held in check by the temperatures of the spring months. The ability of the cotton plant to grow during April and May is much greater than that of the weevils. This gives a margin of which the planter can take advantage.

It has been proposed at various times that late planting would be of advantage in the fight against the weevil, but exhaustive tests made by the Bureau of Entomology and the Louisiana Crop-Pest Commission have demonstrated the fallacy of this proposal.

In the section dealing with natural control it was shown that climatic checks are the most important that the boll weevil experiences. The principal manner in which climatic factors affect the weevil is through the drying of the fruit. Naturally, the more heat and light there is to reach the fallen squares the greater will be the effectiveness of the most important natural means of control. This is the basis for the recommendation that the plants should be given considerable space not only between the rows, but in the drill. Of course, it would be possible to place the plants entirely too far apart, and thus reduce the yield. There is a happy medium, however, at which planters must arrive from experience on their individual places. At the same time varieties should be cultivated which have a minimum tendency toward the formation of leafage.

The work of the insect enemies of the boll weevil is increasing from year to year. This work should be encouraged so far as possible. It happens that several of the recommendations made for other reasons will result in facilitating the work of the enemies of the weevil. This is the case with early planting, wide spacing, and the use of varieties with sparse rather than dense leafage. Even the fall destruction of the stalks is not a disadvantage, because it forces the parasites at the end of the active season to native hosts that carry them through the winter. Wherever possible varieties should be planted which retain a large proportion of the infested squares, because the hanging squares are more favorable for parasite attack than those which fall.

Whenever the squares are picked by hand they should, if practicable, be placed in screened cages, rather than burned or buried. In this way the weevils will be destroyed while the parasites may escape. The screen used on such cages should have meshes at the rate of about 14 to the inch.

Numerous experiments have shown that a large proportion of the weevils buried under 2 inches of moist soil can not reach the surface. Unfortunately, it is not possible to plow the infested squares under 2 inches of soil during the growing season. The operation would result in injury to the root system and cause great shedding.

Nevertheless, it is possible for the planter to follow this practice after maximum infestation has been reached and after the plants have been uprooted. Therefore, every means should be taken at the time of maximum infestation to plow under the infested squares as deeply as possible. This method is of little use in dry regions, but, fortunately, is of great importance in humid regions where other means of control are comparatively lacking in efficiency. Its importance is increased by the occurrence of large areas of so-called stiff soils in the humid area.

In 1909 the Louisiana Crop-Pest Commission published a circular dealing with the results of experiments with powdered arsenate of lead as a practical remedy for the boll weevil. This circular dealt with carefully planned field experiments which showed that the use of this arsenical was attended with great profit during that season. The Bureau of Entomology has investigated this subject for two subsequent seasons. The results have been to a certain extent contradictory, although there is an indication that a definite field of usefulness for the powdered arsenate of lead will be found. The results of this work will be published in due time. The striking results obtained by the Louisiana Crop-Pest Commission in 1909 seem to have been due to peculiar conditions, including a great abundance of insects, which prevailed during that season. The work of the Bureau of Entomology also shows that the greatest benefits will occur when the weevils are most abundant.

SUMMARY OF CONTROL MEASURES.

(1) *The destruction of the weevils in the fall by uprooting and burning or burying the plants.*—This is by far the most important step in control. It is so important that unless it is followed all other means will avail little to the planter.

The burning of the cotton plants is not, of course, a good agricultural practice. It should not be followed except in emergencies. In all other cases the plants should be uprooted as soon as the cotton can be picked, cut by means of stalk choppers, and plowed under immediately. The ground should afterwards be harrowed or dragged to make it still more difficult for the insects to emerge.

In many cases it will be found inadvisable to wait for the uprooting of the plants until all of the cotton is picked. When only a small portion remains for the pickers it is entirely feasible to uproot the plants by means of a turning plow and leave them in the field so that the cotton can be picked. This will hasten the opening of the green bolls and frequently result in a considerable saving to the planter.

(2) *The destruction of the weevils during the winter.*—This is accomplished by the destruction of the places in which the insects hiber-

nate. Many such places are found in the cotton fields or in their immediate vicinity. A certain number of the weevils will, of course, make their way into the heavy woods and other situations beyond the reach of the planter, but many remain where they can be reached.

(3) *Obtaining an early crop.*—The importance of obtaining an early crop has been shown to depend upon the small number of weevils which hibernate successfully, their late emergence from hibernating quarters, and their comparatively slow development during the early part of the season. The obtaining of an early crop is brought about by early preparation of the soil, by early planting, the use of early maturing varieties,[1] a system of upbuilding and fertilization which will stimulate the growth of the plants, and by continuous shallow cultivation during the season.

By early planting we do not mean that the planter should run great risk of loss of stand by frost. Planting at too early a date is as bad as late planting. By early planting we mean the earliest planting that the farmer's experience shows is reasonably safe.

(4) *Increasing the effects of climatic control.*—As has been shown, practically 50 per cent of all the weevil stages throughout the infested territory are destroyed by climatic influences. This means that the power of reproduction of the weevils is reduced by one-half. A planter can increase the advantage in his favor by providing a suitable distance between the plants and between the rows. It is also important to use varieties, where possible, which have a comparatively small leaf area.

(5) *Encouraging the insect enemies of the weevil.*—This is accomplished in part by procedures already recommended and, further, by the use of varieties which have a well-developed tendency to retain the fruit, and which also have a comparatively open structure and small leafage.

(6) *Hand picking of weevils and squares.*—This is a practice of varying importance. Under some conditions it may be highly advisable, under others entirely impracticable; everything depending upon the cheapness with which the work can be done. * * * It is therefore a matter that must be taken into consideration by each individual planter. This subject is now under investigation by this bureau, and the experiments under way will show under what conditions the practice of picking the squares or weevils can be recommended.

Wherever square picking is practiced the best results are likely to follow where the picked-up squares are placed in cages so that the

[1] Some of the best varieties for the humid region (Louisiana, Mississippi, and Alabama) are Cleveland's Big Boll, Cook's Improved, Toole's, and King. In Texas, Mebanes Triumph, Rowden, Lone Star, and other varieties will be found best adapted to boll-weevil conditions. For further information the planter should communicate with the Bureau of Plant Industry or the State Experiment Station.

parasites may escape and continue their work. As a matter of fact, under most conditions it is likely that the encouragement that can be given the parasites by this means is of much more importance than any direct checking of the weevil by the process of hand picking. Wherever squares are burned these enemies of the weevil are destroyed, thus stopping their beneficial work. It is of the utmost importance, however, that the cages in which the squares are held be free from cracks or openings such as result from the shrinkage or warping of the wood in barrels and boxes that are left exposed to the weather, through which the weevils could escape, and that the screen used on them have meshes at the rate of about 14 to the inch.

(7) *Control at gins.*—The use of modern cleaner feeders will eliminate practically all of the weevils from cottonseed. Such devices should be used at least in the case of all seed that is intended for shipment into any infested localities, and especially along the outer border of the infested territory, where wagons may carry infested cottonseed some distance into territory that has not been reached by the weevil. It is important in connection with the cleaner feeders to provide some means for the destruction of the insects that are captured. In some cases where the cleaner feeders are in operation the discharge is allowed to accumulate in an open barrel or box. From such receptacles weevils readily make their way into the seed cotton in storage. It is a simple matter to provide compression rollers through which the discharge from the cleaner feeder is passed. If for any reason the use of compression rollers is impracticable the trash should be fumigated at frequent intervals by means of carbon bisulphid or collected in a closed chamber and burned before the weevils have an opportunity to escape.

(8) *Fumigation of seed.*—This is a means of repression that will be of avail only in the case of shipments of seed into uninfested territory. It has been found that carbon bisulphid is the most satisfactory agent to use. Great care should be taken to insure thoroughness of application.

In addition to the specific means of control enumerated we may mention the prevention of the invasion of new territory by means of quarantines directed against farm commodities that are likely to carry the weevil. It is not necessary to have a quarantine applied to an extended list of articles. Only a few forms of cotton and of cotton by-products need to be considered. The most important is seed cotton. Next in importance are cottonseed and cottonseed hulls. There is no danger in cottonseed meal and scarcely any appreciable danger in baled cotton.

Cottonseed can easily be rendered entirely safe by fumigation with carbon bisulphid.

The use of a crossbar attached to the cultivator to jar the infested squares from the plants has frequently been recommended. Under some conditions this practice should be followed, but under others it is worse than futile. It has been found that in the humid region, including Arkansas, Louisiana, and the eastern portion of Texas, the mortality in hanging squares is greater than in fallen squares. For this reason it is better for the squares to remain on the plants. There is another reason why they should be allowed to remain on the plants, which applies especially to the moist region in which the boll weevil is now doing great damage. This is that the hanging squares are much preferred by the boll-weevil parasites. The records have invariably shown a higher rate of parasitism in hanging squares than in fallen squares. In this way the hanging squares furnish a means for the breeding of parasites and their establishment in the field.

It will be noted that the means of repression of the boll weevil may be divided into two classes, namely, direct and indirect.

The direct means of control are the destruction of the weevils in the fall by destroying the plants and burning or burying the immature stages, hand picking of weevils and squares under some conditions, poisoning with powdered arsenate of lead, the burial of the infested forms at the time of maximum infestation, and the burning of the hibernating weevils in their winter quarters.[1]

The indirect means of control are early planting, the use of early varieties and of fertilizers that will accelerate growth, the improvement of the soil by the incorporation of humus, the selection of fields where the soil is suitable to rapid development, frequent shallow cultivation, the encouragement of the parasites of the weevil by placing the infested squares that may be picked by hand in cages instead of burning them, and the use of machinery which facilitates the various operations in preparing the land and cultivating the crop. These have the effect of increasing the acreage that a hand may cultivate. In view of the fact that the boll weevil forces a reduction in the acreage per hand, this is a consideration of some moment.

[1] Poisoning the adults with powdered arsenate of lead, judging by experiments now under way, will also serve as a direct check. Definite advice can not be given until the field experiments are completed.

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